

# STATE OF COLORADO

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Dedicated to protecting and improving the health and environment of the people of Colorado

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Colorado Department  
of Public Health  
and Environment

July 27, 2012

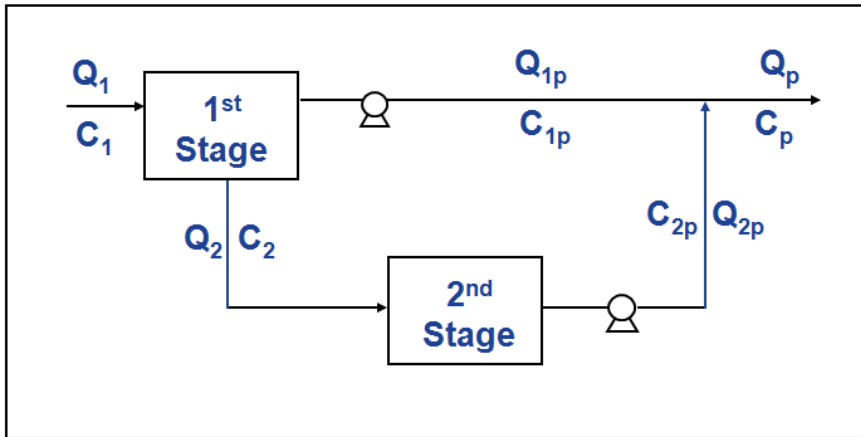
To: Public Water Systems

Subject:            Calculating the water plant's Log Removal Value (LRV) for membrane systems at a surface water treatment plant required to provide additional *cryptosporidium* treatment (Bin 2-4 systems)

To whom it may concern;

The Water Quality Control Division (the Division) of the Colorado Department of Public Health and Environment reviews and accepts membrane filtration for use in Colorado as alternative filtration technologies. The Division performs these reviews this information in accordance with Article 7.1.3(h), 7.2.3 (c), and 7.3.4 (c) of the *Colorado Primary Drinking Water Regulations* (CPDWR). If a membrane filter meets or exceeds the requirements of the *State of Colorado Design Criteria for Potable Water Systems* Parts 1.0.4, 5.0.5, and 5.15 and the CPDWR, the technology may be conditionally accepted for use as an Alternative Filtration Technology subject to the conditions outlined in the document. All surface water systems must comply with treatment technique requirements of Articles 7.1 – 7.3 of the CPDWR and must classify their source water for *cryptosporidium* per the requirements of Article 7.4 of the CPDWR. Public water systems with source waters classified as Bin 2-4 must comply with the additional treatment requirements of Article 7.4 of the CPDWR in addition to the treatment technique requirements outlined in Articles 7.1-7.3 of the CPDWR. ;

Given that section 7.4 of the CPDWR requires a water system that chooses to comply with the additional treatment requirements for *cryptosporidium* to perform log removal value (LRV) calculations for a micro or ultra filtration membrane system, this letter serves as guidance for systems that have source waters that classify as Bin 2-4 and use two stage filtration with membranes. The Division considers a two stage membrane system to be a system where the bulk of the water is filtered through a primary filtration stage (typically >95% of the water) and the backwash effluent from the primary stage is filtered through a second stage of membranes (typically <5% of the water). This does not apply to high pressure nanofiltration and reverse osmosis where the membrane cannot be tested via pressure decay tests on a regular basis. The Division will allow the public water system to calculate a plant-wide LRV instead of taking the worst case LRV which typically occurs on the second stage. Figure 1 shows a typical schematic of a two-stage membrane installation:



**Overall Mass-Balance:**  $C_p Q_p = C_{1p} Q_{1p} + C_{2p} Q_{2p}$

Where:

$C_1, C_2, C_p, C_{1p}, C_{2p}$  = Pathogen Concentration  
 $Q_1, Q_2, Q_p, Q_{1p}, Q_{2p}$  = Flow rates

**Figure 1: Two Stage Membrane Filtration with overall pathogen loading variables and flowrates.**

A typical equation for the above-described scenario would be:

$$Plant LRV = -Log \frac{\sum (Q_i \times 10^{-LRV_i})}{\sum (Q_i)}$$

Where

$Q_i$  is the flow for train i

$LRV_i$  is the LRV for Train i

For a plant with three first stage trains 1 to 3 and two second stage trains A and B, the plant LRV is:

$$Plant LRV = -Log \frac{Q_1 \times 10^{-LRV_1} + Q_2 \times 10^{-LRV_2} + Q_3 \times 10^{-LRV_3} + Q_A \times 10^{-LRV_A} + Q_B \times 10^{-LRV_B}}{Q_1 + Q_2 + Q_3 + Q_A + Q_B}$$

The Division will make a final decision on a case by case basis for these types of water plants which are required to calculate LRV per Article 7.4 of the CPDWR. This decision will be communicated in the approval to construct new drinking water infrastructure and/or by the Compliance Assurance Section of the Division. If you have any questions or comments, please call Tyson Ingels at 303-692-3002.

Sincerely,

Tyson Ingels, P.E.  
 Lead Drinking Water Engineer  
 Engineering Section  
 Water Quality Control Division